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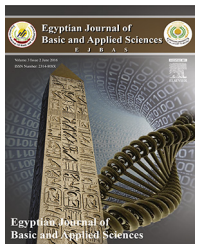

Review Article

Biochemical profile of phytoplankton and its nutritional aspects in some khors of Lake Nasser, Egypt

Howayda H. Abd El-Hady [a,*], *Shadia A. Fathey* [b], *Gamila H. Ali* [c], *Yasmin G. Gabr* [a]

[a] *Hydrobiology Laboratory, Inland Water and Aquaculture Branch, National Institute of Oceanography and Fisheries (NIOF), 101 Kasr El Aini St., Cairo, Egypt*

[b] *Biochemistry Department, Faculty of Science, Ain Shams University, Egypt*

[c] *Water Pollution Research Department, National Research Center, Dokki, Cairo, Egypt*

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ABSTRACT

Lake Nasser has a numerous side extensions known as khors. Four khors were selected, two at the northern region (Kalabsha and Wadi-Abyad) and the others at southern (Tushka and Korosko). Seasonal study was carried out to estimate the quantitative and qualitative phytoplankton biochemical contents at the studied khors. Cyanophyceae was the most dominant group at the studied khors, where *Microcystis aeruginosa*, *Microcystis flos-aquae*, *Lyngbya limnetica*, *Microcystis wesenbergii* and *Merismopedia glauca* were the most dominant species. Protein represents the main biochemical content of phytoplankton at the khors, which generally reflects a physiologically healthy phytoplankton with high relative growth rates. Khor Korosko recorded the highest nutritive characters of phytoplankton proteins, carbohydrates and lipids (6.6 g/l, 14.2 and 4.45 mg/l), contrary to chlorophyll *a* which attained the least value of 71.4 mg/l. Winter was the optimum season for the measured biochemical contents; concurrently with high nitrate value. Flourishing of Copepoda and Cladocera in winter and highly fish muscle contents of protein and lipid at the same time may be attributed to the elevation of the biochemical contents of microalgae. High significant variation ($p \leq 0.05$) was found between the four khors according to the studied phytoplankton biochemical parameters during winter.

* *Corresponding author.* Tel.: +20 01004665455.
E-mail address: Howayda999@hotmail.com (H.H. Abd El-Hady).

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1. Introduction

Lake Nasser was high water quality and faces no threat of degradation due to local sources [1]. The shoreline of Lake Nasser is very irregular, with embayments called khors. There are about 85 long khors, 48 are on the east side and 37 on the west side. The existence of the khors increases greatly the length of the shore (8700 km), the mean length of the khors increases downstream from south to north and all are U-shaped in cross section. The khors surface area covers about 4900 km^2 (79% of total lake surface); while their volume is 86.4 km^3, i.e. 55% of the total lake volume [2,3]. Some khors as Kalabsha, El-Allaqi and Tushka are wide, with a sandy bottom and slope gently; others as El-Sabakha, Singari and Korosko are steep, relatively narrow with a rocky bottom [4].

Algae can be used in the ecological risk assessment (ERA) to determine whether a problem exists, to infer levels of specific stressors in a targeted habitat within the water body [5]. Several factors can contribute to the nutritional value of microalgae, including its size and shape, digestibility (related to cell wall structure and composition), biochemical composition (proteins, carbohydrates and lipids) and the requirements of the animal feeding on the algae. Several studies have attempted to correlate the nutritional value of microalgae to their chemical profile [6,7].

Phytoplankton serve as food for zooplankton which in turn serve as food to almost all larval forms (either meroplanktononic or holoplanktonic) in natural surface water [8]. It is widely known that the addition of microalgae to larval fish culture tanks confers a number of benefits, such as preventing bumping against the walls of the tanks [9], enhancing predation of zooplankton [10], enhancing the nutritional value of zooplankton [11], as well as improving larval digestive [12] and immune functions [13] and as important source of fish oil lipids (polyunsaturated omega-3 and omega-6 fatty acids) and all the essential amino acids [14–17]. Cyanobacteria (especially *Microcystis* sp.) are an important constituent of Nile tilapia diet in Lake Victoria [18].

The aim of this study is to explore, analyze and assess the quantitative and qualitative estimations of phytoplankton biochemical contents at the main khors of Lake Nasser (Tushka, Wadi-Abyad, Kalabsha and Korosko) in relation to the biological environmental conditions.

2. Material and methods

2.1. Area of study

Sampling was carried out seasonally from February 2013 to November 2013 from four selected khors in Lake Nasser (Fig. 1 and Table 1). Two northern (Kalabsha and Wadi-Abyad with 7 and 6 sites, respectively), and two southern (Khor Tushka, 6 sites) and (Khor Korosko, 8 sites). The sampling program was undertaken through National Institute of Oceanography and Fisheries (NIOF) in order to study environmental conditions and Fisheries of Lake Nasser.

Table 1 – The locations of the selected khors.

Khors	Latitude	Longitude	Distance from high dam (Km)	Depth (m)
Tushka	22° 36.32′	31° 55.21′	240	8–28
Wadi-Abyad	23° 20.08′	32° 56.12′	74.3	20–36
Kalabsha	23° 33.41′	32° 52.04′	47.7	12–37
Korosko	22° 37.65′	32° 24.14′	167.2	28–46

2.2. Physico-chemical characteristics

Water temperature, pH and electric conductivity (EC) were measured by Multiprob Hydrolab (Model CRISON-Spain), transparency was measured by Secchi Disc, dissolved oxygen (DO) and nutrients, nitrogen (NO_2 and NO_3) and phosphorus PO_4 were estimated by using the standard methods [19].

2.3. Phytoplankton identification

Lugol-preserved subsamples were dispensed into glass Sedgwick-Rafter cells and examined using IB2FL inverted microscope. Species composition and dominance in the samples were determined semi-quantitatively [20–22]. The main references used in phytoplankton identification were [23–31].

2.4. Biochemical sampling and analysis

A known volume of water sample were collected by plastic bottles from the chosen sites, then sieved and filtered through zooplankton net (100 µm mesh size) to separate macrozooplankton. Defined volume of the filtered water was re-filtered on Whatman GF/F (0.7 µm pore diameter) fiber circles and the samples were transferred to the laboratory in ice tanks to determine the biochemical parameters of the separated phytoplankton. Chlorophyll *a* values were analyzed by Trichromatic equation [32]. Total protein content was determined by Biuret method [33]. Carbohydrate contents were measured and compared with glucose as a reference sugar according to Phenol-sulphuric acid method [34]. Whereas total lipid content was determined by the Sulphophosphovanillin procedure (SPV) using cholesterol as standard [35].

2.5. Statistical analysis

Correlation coefficient (r) was performed using Microsoft Excel 2013 to estimate the relation between chlorophyll *a* and the three biochemical parameters (proteins, lipids and carbohydrates) in order to verify the correlation between different variables. Two-way ANOVA was employed to evaluate the variability of the concentration of each biochemical parameters with respect to the studied khors during different seasons, probabilities less than ($p \leq 0.05$) were considered statistically significant variation by SAS, version 9.1 (2004).

3. Results and discussion

Microalgae respond to physicochemical variations in the surrounding environment, but the nature and extent of such